PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-047952
(43)Date of publication of application : 18.02.2000

(51)Int.Cl. G06F 13/00
G06F 12/00

(21)Application number : 10-211357
(22)Date of filing : 27.07.1998

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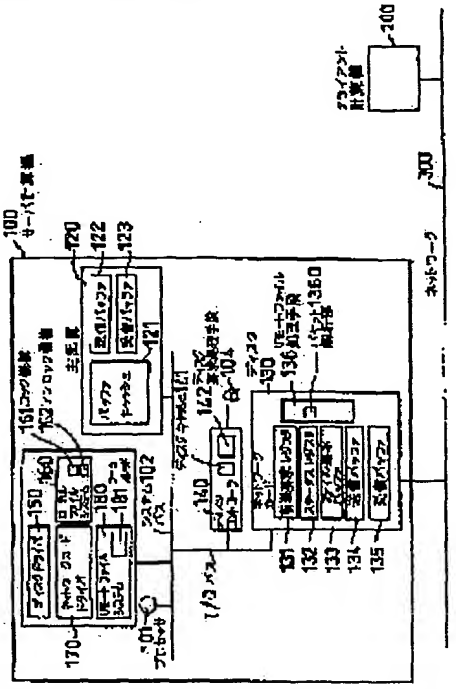
(54) NETWORK FILE SERVER SYSTEM AND FILE MANAGING METHOD IN THE SYSTEM

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a means for efficiently performing I/O processing while minimizing the use of processor, main storage and system bus resource of a server computer by directly transferring data between a network card and an I/O device such as network adapter or disk controller.
SOLUTION: In this network file server system, in the case of processing a remote file system request through a remote file processing means 136 by a network card 130 while using a file on a disk through a local file system 160 for an application or operating system(OS) to be operated on a server computer 100, data are directly transferred between a disk controller 140 and the network card 130. Thus, the number of times of data transfer using a main memory 120 between the disk controller 140 and network card 130 is decreased so that high-speed processing is enabled.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

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CLAIMS

[Claim(s)]
[Claim 1] Manage the above-mentioned storage with the means of communications characterized by providing the following, and the file on this storage is managed. A local file control means with the function to return the information which pinpoints the position of the disk which stores the above-mentioned file to the demand which asks the position on the above-mentioned storage of the above-mentioned file, It has a remote file control means to write the file on the above-mentioned storage based on the content of the remote file system demand from the above-mentioned client computer. The above-mentioned remote file-processing section analyzes the packet which the above-mentioned receive buffer received. The remote file system demand which is an operation demand to the file which the above-mentioned local file control means which the above-mentioned client computer contained in this packet transmitted manages is taken out. When this remote file system demand needs the data transfer from the above-mentioned storage which the above-mentioned local file control means manages, The demand which asks in which position of the above-mentioned storage the file exists is given to the above-mentioned local file control means. A transmitting packet will be created, if it demands to transmit to the above-mentioned storage control means at the above-mentioned transmission buffer based on the positional information which was able to obtain the data of the file concerned and this data is stored in the above-mentioned transmission buffer. The above-mentioned client computer is answered in a remote file system demand. When the above-mentioned remote file system demand needs the data transfer to the above-mentioned storage, The demand which asks in which position of the above-mentioned storage the file concerned exists is given to the above-mentioned local file control means. The data stored in the above-mentioned receive buffer are directly transmitted to the above-mentioned storage control means. The data which the above-mentioned storage control means store in the above-mentioned receive buffer based on the position obtained previously are written in the above-mentioned storage. When the reply to a remote file system demand is performed to the above-mentioned client computer and the above-mentioned remote file system demand does not need the data transfer from the above-mentioned storage The network file server system characterized by passing the demand to the above-mentioned remote file control means. The server computer which offers files, such as various applications. Two or more client computers which access the file which this server computer offers. It is the storage with which it is the network file server system which consists of the network which connects the above-mentioned server computer and the above-mentioned client computer, and the above-mentioned server computer stores information, such as a file. The transmission buffer section which stores the packet which considers protocol processing of the packet transmitted and received to the above-mentioned client computer as the storage control means which control this storage, and transmits to the above-mentioned client computer, the receive buffer section which stores the packet which received from the above-mentioned client computer, and the remote file-processing section which performs processing based on the remote file system demand from the above-mentioned client computer.
[Claim 2] The network file server system which consists of the network which connects the

server computer which is characterized by providing the following, and which offers files, such as various applications, two or more client computers which access the file which this server computer offers, and the above-mentioned server computer and the above-mentioned client computer. The above-mentioned server computer is storage which stores information, such as a file. Storage control means which control this storage. Means of communications which prepared the transmission buffer section which stores the packet which carries out protocol processing of the packet transmitted and received to the above-mentioned client computer, and transmits to the above-mentioned client computer, the receive buffer section which stores the packet which received from the above-mentioned client computer, and the remote file-processing section which performs processing based on the remote file system demand from the above-mentioned client computer. Store the data of the above-mentioned file in the puffer cache section on the primary storage of the above-mentioned server computer, and the operation to the above-mentioned file When it carries out on the above-mentioned buffer cache section and the data of the above-mentioned file are stored on the buffer cache section The function to return the address of the data of the file concerned on the above-mentioned buffer cache to this file demand, The function to return the information which pinpoints the position of the disk which stores the above-mentioned file to the demand which manages the above-mentioned storage, manages the file on this storage, and asks the position on the above-mentioned storage of the above-mentioned file.
[Claim 3] The network file server system which consists of the network which connects the server computer which is characterized by providing the following, and which offers files, such as various applications, two or more client computers which access the file which this server computer offers, and the above-mentioned server computer and the above-mentioned client computer. The above-mentioned server computer is storage which stores information, such as a file. Storage control means which control this storage. Means of communications which prepared the transmission buffer section which stores the packet which carries out protocol processing of the packet transmitted and received to the above-mentioned client computer, and transmits to the above-mentioned client computer, the receive buffer section which stores the packet which received from the above-mentioned client computer, and the remote file-processing section which performs processing based on the remote file system demand from the above-mentioned client computer. Store the data of the above-mentioned file in the puffer cache section on the primary storage of the above-mentioned server computer, and the operation to the above-mentioned file When it carries out on the above-mentioned buffer cache section and the data of the above-mentioned file are stored on the buffer cache section The function to return the address of the data of the file concerned on the above-mentioned buffer cache to this file demand, The function to secure the above-mentioned buffer cache section which stores the file concerned based on the above-mentioned file demand, and to return this address when the data of the above-mentioned file are not stored on the buffer cache section, The function to return the information which pinpoints the position of the disk which stores the above-mentioned file to the demand which manages the above-mentioned storage, manages the file on this storage, and asks the position on the above-mentioned storage of the above-mentioned file.
[Claim 4] The network file server system which consists of the network which connects the server computer which is characterized by providing the following, and which offers files, such as various applications, two or more client computers which access the file which this server computer offers, and the above-mentioned server computer and the above-mentioned client computer. The above-mentioned server computer is storage which stores information, such as a file. Storage control means which control this storage. Means of communications which carried out protocol processing of the packet transmitted and received to the above-mentioned client computer, prepared the transmission buffer section which stores the packet which transmits to the above-mentioned client computer, and the receive buffer section which stores the packet which received from the above-mentioned client computer, and prepared the remote file-processing section which processes based on the remote file system demand from the above-mentioned client computer. The function of notifying the positional information on the function of returning the information which pinpoints the position of the disk which stores the above-

mentioned file to the demand which manages the above-mentioned storage, manages the file on this storage, and asks the position on the above-mentioned storage of the above-mentioned file, and the storage store this file in case the writing to the above-mentioned file, deletion, creation, etc. operate, and the file positional information it is the information specify this file to the above-mentioned means of communications.

[Claim 5] Manage the above-mentioned storage with the means of communications characterized by providing the following, and the file on this storage is managed. A local file control means with the function to return the information which pinpoints the position of the disk which stores the above-mentioned file to the demand which asks the position on the above-mentioned storage of the above-mentioned file, It has a remote file control means to write the file on the above-mentioned storage based on the content of the remote file system demand from the above-mentioned client computer. The above-mentioned remote file-processing section analyzes the packet which the above-mentioned receive buffer received. The remote file system demand which is an operation demand to the file which the above-mentioned local file control means which the above-mentioned client computer contained in this packet transmitted manages is taken out. When this remote file system demand needs the data transfer from the above-mentioned storage which the above-mentioned local file control means manages, The demand which asks in which position of the above-mentioned storage the file exists is given to the above-mentioned local file control means. A transmitting packet will be created, if it demands to transmit to the above-mentioned storage control means at the above-mentioned transmission buffer based on the positional information which was able to obtain the data of the file concerned and this data is stored in the above-mentioned transmission buffer. The above-mentioned client computer is answered in a remote file system demand. When the above-mentioned remote file system demand needs the data transfer to the above-mentioned storage, The demand which asks in which position of the above-mentioned storage the file concerned exists is given to the above-mentioned local file control means. The data stored in the above-mentioned receive buffer are directly transmitted to the above-mentioned storage control means. The data which the above-mentioned storage control means store in the above-mentioned receive buffer based on the position obtained previously are written in the above-mentioned storage. When the reply to a remote file system demand is performed to the above-mentioned client computer and the above-mentioned remote file system demand does not need the data transfer from the above-mentioned storage The file management method in the network file server system characterized by passing the demand to the above-mentioned remote file control means. The server computer which offers files, such as various applications. Two or more client computers which access the file which this server computer offers. It is the storage with which it is the file management method in the network file server system which consists of the network which connects the above-mentioned server computer and the above-mentioned client computer, and the above-mentioned server computer stores information, such as a file. The transmission buffer section which stores the packet which considers protocol processing of the packet transmitted and received to the above-mentioned client computer as the storage control means which control this storage, and transmits to the above-mentioned client computer, the receive buffer section which stores the packet which received from the above-mentioned client computer, and the remote file-processing section which performs processing based on the remote file system demand from the above-mentioned client computer.

[Claim 6] The file management method of the network file server system which consists of a network which connects the server computer which is characterized by providing the following, and which offers files, such as various applications, two or more client computers which access the file which this server computer offers, and the above-mentioned server computer and the above-mentioned client computer. The above-mentioned server computer is storage which stores information, such as a file. Storage control means which control this storage. Means of communications which prepared the transmission buffer section which stores the packet which carries out protocol processing of the packet transmitted and received to the above-mentioned client computer, and transmits to the above-mentioned client computer, the receive buffer section which stores the packet which received from the above-mentioned client computer, and

the remote file-processing section which performs processing based on the remote file system demand from the above-mentioned client computer. Store the data of the above-mentioned file in the puffer cache section on the primary storage of the above-mentioned server computer, and the operation to the above-mentioned file When it carries out on the above-mentioned buffer cache section and the data of the above-mentioned file are stored on the buffer cache section The function to return the address of the data of the file concerned on the above-mentioned buffer cache to this file demand, The function to return the information which pinpoints the position of the disk which stores the above-mentioned file to the demand which manages the above-mentioned storage, manages the file on this storage, and asks the position on the above-mentioned storage of the above-mentioned file.

[Claim 7] The file management method of the network file server system which consists of a network which connects the server computer which is characterized by providing the following, and which offers files, such as various applications, two or more client computers which access the file which this server computer offers, and the above-mentioned server computer and the above-mentioned client computer. The above-mentioned server computer is storage which stores information, such as a file. Storage control means which control this storage. Means of communications which prepared the transmission buffer section which stores the packet which carries out protocol processing of the packet transmitted and received to the above-mentioned client computer, and transmits to the above-mentioned client computer, the receive buffer section which stores the packet which received from the above-mentioned client computer, and the remote file-processing section which performs processing based on the remote file system demand from the above-mentioned client computer. Store the data of the above-mentioned file in the puffer cache section on the primary storage of the above-mentioned server computer, and the operation to the above-mentioned file When it carries out on the above-mentioned buffer cache section and the data of the above-mentioned file are stored on the buffer cache section The function to return the address of the data of the file concerned on the above-mentioned buffer cache to this file demand, The function to secure the above-mentioned buffer cache section which stores the file concerned based on the above-mentioned file demand, and to return this address when the data of the above-mentioned file are not stored on the buffer cache section, The function to return the information which pinpoints the position of the disk which stores the above-mentioned file to the demand which manages the above-mentioned storage, manages the file on this storage, and asks the position on the above-mentioned storage of the above-mentioned file.

[Claim 8] The file management method of the network file server system which consists of a network which connects the server computer which is characterized by providing the following, and which offers files, such as various applications, two or more client computers which access the file which this server computer offers, and the above-mentioned server computer and the above-mentioned client computer. The above-mentioned server computer is storage which stores information, such as a file. Storage control means which control this storage. Means of communications which carried out protocol processing of the packet transmitted and received to the above-mentioned client computer, prepared the transmission buffer section which stores the packet which transmits to the above-mentioned client computer, and the receive buffer section which stores the packet which received from the above-mentioned client computer, and prepared the remote file-processing section which processes based on the remote file system demand from the above-mentioned client computer. The function of notifying the positional information on the function of returning the information which pinpoints the position of the disk which stores the above-mentioned file to the demand which manages the above-mentioned storage, manages the file on this storage, and asks the position on the above-mentioned storage of the above-mentioned file, and the storage store this file in case the writing to the above-mentioned file, deletion, creation, etc. operate, and the file positional information it is the information specify this file to the above-mentioned means of communications.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention accesses the file on a server computer through networks, such as a public correspondence network and LAN (Local Area Network) of a cable and radio, from two or more client computers, and relates to the file management method in the network file server system which transmits and receives data, and a network file server system.
[0002]
[Description of the Prior Art] As conventionally shown in drawing 8 , in the network file server 10, it was what exchanges information between the client computer 25 and a network file server 10. That is, the packet which stored the file manipulation demand reaches the network card 18 of a network file server 10 (it is hereafter called the server computer 10) via the networks 24, such as LAN, from (1) client computer 25.
[0003] (2) The network driver 20 transmits the packet which reached the network card 18 of the server computer 10 to a primary storage 14 from the receive buffer 19 of the network card 18.
[0004] (3) The protocol stack 21 which analyzes communications protocols, such as TCP/IP, analyzes the content of a packet, takes out the file manipulation demand stored in the packet, and passes the remote file system 22.
[0005] (4) The remote file system 22 passes a file manipulation demand to the local file system 23. The local file system 23 is a file system which manages the disk 17 of the server computer 10.
[0006] (5) The local file system 23 processes a file manipulation demand. The result is returned to the remote file system 22.
[0007] (6) The remote file system 22 creates the packet which stored the result, and transmits a result to the client computer 25 via a protocol stack 21, the network card 18, and a network 24.
[0008] The software which processes the packet which arrived is the network driver 20, a protocol stack 21, the remote file system 22, and the local file system 23. These shall be installed on storage, such as a disk.
[0009] The processor 11 of the server computer 10 performs such software on a primary storage 14. In processing of a file manipulation demand, the data between a disk 17 and the network card 18 are exchanged via a primary storage 14.
[0010] In the old server computer 10, processing of the protocol stack 21 which realizes reliable data transmission and reception took time, and many processor resources were consumed.
[0011] Moreover, in network file service etc., an exchange of data occurs using a disk controller 16 and the network card 18. Both of the devices are connected to I/O bus 13 (it realizes by the PCI bus etc.) of the server computer 10.
[0012] Therefore, after the software (the processor of a server computer performs) which controls the device of the network card 18 and disk controller 16 grade processed by once transmitting data to a primary storage until now, data were further transmitted to each device.
[0013]
[Problem(s) to be Solved by the Invention] If it was in the conventional server computer 10 as

mentioned above, processing of the protocol stack 21 which realizes reliable data transmission and reception took time, and many processor resources were consumed. Moreover, in network file service etc., it was what an exchange of data generates using a disk controller 16 and the network card 18. Both of the devices are connected to I/O bus 13 (it realizes by the PCI bus etc.) of the server computer 10.
[0014] Therefore, after the software (the processor of a server computer performs) which controls the device of the network card 18 and disk controller 16 grade processed by once transmitting data to a primary storage conventionally, data were further transmitted to each device.
[0015] Then, in consideration of the above-mentioned situation, accomplished this invention, and it cancels the above-mentioned fault. The file on a server computer is accessed through networks, such as a public correspondence network and LAN of a cable and radio, from two or more client computers. By being in the network file server system which transmits and receives data, and exchanging data directly among I/O devices, such as a network adapter and a disk controller Use of the processor of a server computer, a primary storage, and system bus resources is suppressed to the minimum, and it aims at offering the file management method in the network file server system which can perform I/O processing efficiently, and a network file server system.
[0016]
[Means for Solving the Problem] this invention in order to attain the above-mentioned purpose the network file server system of this invention The server computer which offers files, such as various applications, and two or more client computers which access the file which this server computer offers, It is the network file server system which consists of a network which connects the above-mentioned server computer and the above-mentioned client computer. the above-mentioned server computer The storage which stores information, such as a file, and the storage control means which control this storage, Protocol processing of the packet transmitted and received to the above-mentioned client computer is carried out. The packet which transmits to the above-mentioned client computer The means of communications which prepared the transmission buffer section to store, the receive buffer section which stores the packet which received from the above-mentioned client computer, and the remote file-processing section which performs processing based on the remote file system demand from the above-mentioned client computer. A local file control means with the function to return the information which pinpoints the position of the disk which stores the above-mentioned file to the demand which manages the above-mentioned storage, manages the file on this storage, and asks the position on the above-mentioned storage of the above-mentioned file, It has a remote file control means to write the file on the above-mentioned storage based on the content of the remote file system demand from the above-mentioned client computer. The above-mentioned remote file-processing section analyzes the packet which the above-mentioned receive buffer received. The remote file system demand which is an operation demand to the file which the above-mentioned local file control means which the above-mentioned client computer contained in this packet transmitted manages is taken out. When this remote file system demand needs the data transfer from the above-mentioned storage which the above-mentioned local file control means manages, The demand which asks in which position of the above-mentioned storage the file exists is given to the above-mentioned local file control means. A transmitting packet will be created, if it demands to transmit to the above-mentioned storage control means at the above-mentioned transmission buffer based on the positional information which was able to obtain the data of the file concerned and this data is stored in the above-mentioned transmission buffer. The above-mentioned client computer is answered in a remote file system demand. When the above-mentioned remote file system demand needs the data transfer to the above-mentioned storage, The demand which asks in which position of the above-mentioned storage the file concerned exists is given to the above-mentioned local file control means. It demands to transmit to the above-mentioned storage control means at the above-mentioned transmission buffer based on the positional information which was able to obtain the data of a file. If this data is stored in the above-mentioned transmission buffer, will create a transmitting packet and the above-mentioned

client computer will be answered in a remote file system demand. When the above-mentioned remote file system demand needs the data transfer to the above-mentioned storage, The demand which asks in which position of the above-mentioned storage the file concerned exists is given to the above-mentioned local file control means. The data stored in the above-mentioned receive buffer are directly transmitted to the above-mentioned storage control means. The data which the above-mentioned storage control means store in the above-mentioned receive buffer based on the position obtained previously are written in the above-mentioned storage. When the reply to a remote file system demand is performed to the above-mentioned client computer and the above-mentioned remote file system demand does not need the data transfer from the above-mentioned storage, it is characterized by constituting so that the demand may be passed to the above-mentioned remote file control means.
[0017] In case a network card processes a remote file system demand, the application and the operating system (OS) which operate on a server computer using the file on a disk through a local file system according to such composition, transmitting immediate data between a disk controller and a network card can perform high-speed processing by reducing the number of times of the data transfer using the primary storage between a disk controller and a network card.
[0018] Furthermore, only a Network File System demand is sent to the remote file system (the processor of a server computer performs) proposed by this invention among the packets which the network card interpreted. At this time, the number of times of data transfer can be reduced from before by sending only a demand to the primary storage of a server computer, and carrying out the direct DMA transfer of the data of a file etc. between a network card and a disk controller.
[0019] If the above-mentioned local file control means is equipped with the function which notifies the positional information on the storage which stores a file with the demand, and the file positional information which is information which specifies this file to the above-mentioned means of communications in addition to this composition, the disk positional information of a file can be obtained still at high speed.
[0020] Moreover, the application and OS which operate on a server computer using the file on a disk through a local file system in addition to this composition In case a network card processes a remote file system demand, the data of the buffer cache on the primary storage which a local file system manages by transmitting to a network card directly Can perform high-speed processing and further an exchange of data with the disk generated in the remote file system demand by storing in a buffer cache Next, the data on a buffer cache can be used to the demand (the application on a server computer lets a local file system pass, or a client computer is as a remote file system demand) to the same file.
[0021]
[Embodiments of the Invention] Hereafter, the gestalt of 1 operation of this invention is explained with reference to a drawing.
[0022] Drawing 1 is the block diagram having shown the network file server structure of a system concerning this operation gestalt. Composition required for explanation of this operation gestalt is shown, and other composition is omitted.
[0023] The networks 300, such as a public correspondence network and LAN of a cable and radio, connect with the server computer 100, and the client computer 200 accesses the file on the server computer 100. This file is a file corresponding to the various applications installed on the server computer, or other applications.
[0024] A processor 101 controls each part of the server computer 100.
[0025] A system bus 102 connects and carries out various data transfer of primary-storage 120 grade and the processor 101.
[0026] I/O bus 103 connects I/O equipment and system buses 102, such as input meanses, such as the network card 130, a disk controller 140, a keyboard that is not illustrated, and a mouse, and a display, and transmits various data.
[0027] A primary storage 120 is a primary storage of the server computer 100, and is equipped with the buffer cache 121, a transmission buffer 122, and a receive buffer 123.

[0028] The remote file system 180, the local file system 160, the network card driver 170, and a disk driver 150 are software, are saved on the storage of disk 104 grade, and are performed by the processor 101.
[0029] The remote file system 180 processes writing the file on the server computer 100 based on the content of a file system demand by the worker thread 181 etc.
[0030] The local file system 160 manages the disk 104 with which the server computer 100 is equipped, and is equipped with the lock function 161 and the unlocking function 162. About the function of the lock function 161 and the unlocking function 162, it mentions later.
[0031] The network card driver 170 controls the network card 130.
[0032] A disk driver 150 controls a disk 104 by the disk controller 140.
[0033] The server computer 100 is equipped with the network card 130 which performs protocol processing for performing transmission and reception of the client computer 200 and data. As a result of performing protocol processing of the packet transmitted and received between the server computer 100 and the client computer 200, when the packet is not the file system demand whose R/W etc. carries out the file on the server computer 100 from the client computer 200, this network card 130 cooperates with the network card driver 170, and performs the same processing as the usual network card.
[0034] Moreover, the network card 130 processes writing the file on the server computer 100 based on the content of a file system demand etc. in harmony with the network card driver 170 which operates on the server computer 100, and the worker thread 181 on the remote file system 180, when the above-mentioned packet which carries out transmission and reception is a file system demand.
[0035] The above-mentioned network card 130 consists of the following.
[0036] Perform protocol processing of a receive packet, and when the receive packet is a file system demand The file demand buffer 133 and receive packet which store the content of the packet which a remote file-processing means 136 to perform the processing, and the remote file-processing means 136 analyzed in the usual packet Or it consists of the status register 132 which stores the information which shows a file system demand etc., the receive buffer 135 which once stores the packet transmitted from the alien machine, a transmission buffer 134 which accumulates the packet which should transmit, and a transfer-request register 131.
[0037] Data transfer of the transfer-request register 131 is carried out to the address of the storing origin of data from there, and the information on the address of the point which stores the data is stored. For example, when transmit data is on the buffer cache 121, the address on the buffer cache 121 of the data and the address on the transmission buffer 134 which is the data transfer point are stored. When received data are on a receive buffer 135, the address on the receive buffer 135 of the data and the address on the buffer cache 121 which is the data transfer point are stored.
[0038] The value which shows the status stored in a status register 132 is carried out as follows here. 1 shows read/write demand reception of a file system, 2 usually shows packet reception, and 3 shows DMA transfer completion, and 4 shows the usual packet transmitting processing.
[0039] The file demand buffer 133 consists of the remote file system demand 1330 (a lead, a light, in addition to this), the target file name 1331, its offset 1332, a data length 1333, and a data address 1334, as shown in drawing 2 .
[0040] The local file system 160 manages the disk with which the server computer 100 is equipped. That is, a file is stored on a disk 104 and functions, such as creation of a file, a lead, a light, and deletion, are offered. The buffer cache 121 is created on a primary storage 120, and the cache of the data of a file is carried out. Furthermore, it has the following functions.
[0041] 1. Judge whether the content to which the file corresponds is in the buffer cache 121 by considering a file name, offset, and a data length as an input. In being in the buffer cache 121, it returns the address of the buffer.
[0042] 2. Lock function 161 to forbid file manipulation demand to corresponding buffer by considering the address of buffer as input, and unlocking function 162 to cancel it.
[0043] 3. Return the position (disk block) of the disk which stores the corresponding data by considering a file name, offset, and a data length as an input.

[0044] A disk controller 140 is equipped with the disk cache 141 which once stores the disk demand processing means 142 and the data which read from the disk 104 or are written in a disk 104.
[0045] The network card driver 170 which the server computer 100 performs is equipped with the following functions.
[0046] 1. Process interruption from the network card 130.
[0047] 2. Transmit and receive the usual packet.
[0048] 3. Secure a transmission buffer 122 and a receive buffer 123 on a primary storage 120.
[0049] The worker thread 181 which the processor 101 of the server computer 100 performs receives a remote file system demand, and takes charge of the processing.
[0050] Processing begins from the place where, as for a remote file system demand, the client computer 200 transmits a demand to the server computer 100. Hereafter, the client computer 200 advances a remote file system demand, and the flow chart of drawing 3 explains how the server computer 100 processes the demand.
[0051] First, if the remote file-processing means 136 of the network card 130 has reception of a packet from the client computer 200, it will perform the following operation. Here, the example which uses Ethernet for communication and uses TCP/IP for the protocol is explained.
[0052] When the packet addressed to network card 130 is sent on a network 300, the packet is accumulated to a receive buffer 135 (Step A1).
[0053] The packet accumulated to the receive buffer 135 is analyzed, and the packet analysis section 1360 which performs protocol processing of TCP/IP analyzes the data division of a packet, and judges whether it is the protocol which can be processed (Step A2).
[0054] In the case of the protocol which cannot be processed (No of Step A2), Step A8 is processed.
[0055] In the case of the protocol which can be processed (Yes of Step A2), the packet analysis section 1360 performs protocol processing (Step A3).
[0056] Next, it judges whether it is the demand to the remote file system 180 (Step A4). Here, since it is transmitted to the port of TCP/IP defined beforehand, the demand to the remote file system 180 can be easily judged, if the port number of a packet is supervised.
[0057] In the demand to the remote file system 180, (Yes of Step A4) and a status register 132 are set to 1 (read/write demand reception of a file system) (step A5).
[0058] A file system demand is taken out from a packet and it stores in the file demand buffer 133. The demand consists of file manipulation, a file name, offset, a data length, etc. Furthermore, when a demand is a lead, the transmission buffer 134 on the network card 130 is secured, and the address is stored in the data address of the file demand buffer 133. In a light demand, the address of the receive buffer 135 on the network card 130 which stored the data which should be written in is stored in the data address of the file demand buffer 133 (Step A6).
[0059] Then, interruption is applied to a processor (Step A7).
[0060] When it is not the demand to the remote file system 180, in file system demands other than a lead and light processing, a packet is transmitted to the receive buffer 135 on the primary storage 120 which the network card driver 170 secured beforehand as (No of Step A4), and a usual packet. A status register is set to 2 (usually packet reception) (Step A8), and interruption is applied to a processor (Step A7).
[0061] When it is processing with much data transfer, data are directly exchanged between the network card 130 and a disk controller 140 by the method of proposing by this invention. In explanation of this example, although only the lead and the light demand are treated, in addition if there is a demand with the large amount of data transfer, it will process similarly.
[0062] Next, processing operation of the DMA transfer of the network card 130 is explained with reference to the flow chart of drawing 4 .
[0063] Data are sent to the transmission place address by the DMA transfer from the transmitting agency address set to the transfer-request register 131 (storing) (Step B1).
[0064] A status register 132 is set to 3. 3 shows DMA transfer completion (step B-2).
[0065] Interruption is applied to a processor (Step B3).
[0066] Next, the flow chart of drawing 5 explains processing operation of transmission of the

network card 130.
[0067] By the packet analysis section 1360, a packet judges whether it is the usual packet transmission (Step C1).
[0068] In the usual packet transmission (Yes of Step C1), the usual packet transmission is performed (Step C2). Then, a status register 132 is set to 4 (Step C3 (4 shows the usual packet transmitting processing)), and interruption is applied to a processor (Step C4).
[0069] When it is not the usual packet transmission (No of Step C1), the data 134 of a transmission buffer and the answer to the cline ANTO computer 200 from a file demand are created (Step C5). Protocol processing is performed by the packet analysis section 1360 about this created packet (Step C6). A packet is transmitted to a network (Step C7).
[0070] The network card driver 170 is network card control software which the processor 101 of the server computer 100 performs. The flow chart of drawing 6 explains the processing operation.
[0071] A processor receives interruption and the interrupt handler of the network card driver 170 is called.
[0072] A network card driver interrupt handler judges the demand to the remote file system 180, and the usual packet by investigating the status register of the network card 130 (Step D1).
[0073] When it is not the demand to the remote file system 180 (i.e., when the value stored in the status register 132 is except one), (No of Step D1) and the interrupt handler of the network card driver 170 carry out the same operation as the usual network card driver 170.
[0074] Here, a status register 132 judges whether it is 2 (Step D4).
[0075] When the value stored in the status register 132 is 2 (Yes of Step D4), the interrupt handler of the network card driver 170 removes a header (Ethernet frame information) unnecessary to protocol processing of a high order among the data of the packet which the network card 130 transmitted etc., and passes it to protocol drivers (TCP/IP etc.) (Step D5). Since it becomes the same processing as the usual packet reception henceforth, explanation is omitted here.
[0076] When the value stored in the case 132 of a demand, i.e., status register, to the remote file system 180 is 1, (Yes of Step D1) and the interrupt handler of the network card driver 170 take out a file demand from the file demand buffer 133 of the network card 130 (Step D2).
[0077] The worker thread 181 which processes this remote file system demand is started, and a demand is passed (Step D3).
[0078] When the value stored in the status register 132 is except two (No of Step D4) (however, 1 is already excepted), the value of a status register 132 judges whether it is 3 (Step D6).
[0079] When the value of a status register 132 is 3 (Yes of Step D6), the thread which is demanding the DMA transfer is started (Step D7).
[0080] When the value of a status register 132 is except three (No of Step D6) (however, 1 and 2 are already excepted), the value of a status register 132 judges whether it is 4 (Step D8).
[0081] Processing is ended when the value of a status register 132 is except four (No of Step D8) (however, 1, and 2 and 3 are already excepted).
[0082] When the value of a status register 132 is 4 (Yes of Step D8), the usual completion processing of packet transmitting is performed (Step D9).
[0083] By the above and processing operation of the flow chart of drawing 6 , interruption processing of the network card driver 170 is completed now, and the worker thread 181 (remote file system processing is performed) which a processor performs performs henceforth a series of processing operation explained below.
[0084] This processing operation is explained with reference to the flow chart of drawing 7 .
[0085] The passed file manipulation boils the worker thread 181 in a lead, a light, and other operations, and, therefore, it performs the following processings.
[0086] First, the file manipulation to which the worker thread 181 was passed judges whether it is a lead demand (Step E1).
[0087] In a lead demand (Yes of Step E1), the worker thread 181 investigates whether a portion to lead exists in the buffer cache 121 on a primary storage 120 from the file of a file demand, offset, and a data length using the function of the local file system 160 (Step E2).

[0088] When a buffer exists (Yes of Step E2), the address of the corresponding buffer can be acquired.
[0089] The following processings are performed when it exists in the buffer cache 121.
[0090] Operation which locks the corresponding buffer is performed using the function of the local file system 160 (Step E3). When the new operation demand to the buffer comes by this operation, it means performing the exclusion delayed in processing of the demand.
[0091] The worker thread 181 sets the address of the data on the buffer cache 121 which wants to lead the transfer-request register 131, and the address on the transmission buffer 134 of the network card 130 which stores this data (storing), gives the demand which carries out the DMA transfer of the content of the buffer of the buffer cache 121 to the network card 130 to the remote file-processing means 136 of the network card 130 based on this stored address, and waits for the completion (Step E4).
[0092] The remote file-processing means of the network card 130 carries out the DMA transfer of the data which the address of the buffer on the primary storage 120 which prepared the buffer for the transmission buffer 134 on the network card 130, and was passed to it points out in response to the above-mentioned DMA demand (Step E5).
[0093] After a DMA transfer is completed, the remote file-processing means 136 of the network card 130 sets a status register 132 to 3 (DMA transfer completion), and applies interruption to a processor (Step E6).
[0094] The interruption routine of the network card driver 170 is called. An interruption routine recognizes that it is interruption of DMA transfer completion by reading a status register 132. The worker thread 181 for which it is waiting by processing of Step E5 is started, and interruption processing is ended (Step E7).
[0095] The worker thread 181 advances a packet Request to Send to the remote file-processing means 136 of the network card 130 (Step E8).
[0096] Since the data to a remote file system demand (lead demand) are contained in the transmission buffer on the network card 130 by the transfer of (2-3), the rest should just perform transmission.
[0097] The remote file-processing means 136 of the network card 130 creates the header of an Ethernet packet, in order to return the data of a transmission buffer 134 to a transmitting agency (client computer 200 which advanced the lead demand), and it performs transmission (Step E9).
[0098] The worker thread 181 cancels the lock to the buffer of the buffer cache 121 of a primary storage 120 using the function of the local file system 160 (Step E10). Henceforth, other threads, a process, etc. can perform operation to the corresponding buffer.
[0099] The following operations are performed when it does not exist in a buffer (No of Step E2).

[0100] The worker thread 181 investigates the disk block which is needed by read-out operation of a file using the function of the local file system 160. It investigates whether the data required of which portion on a disk exist from a file name and the information on offset. Since the position on a disk 104 is usually managed by the disk block number etc., a disk block number is obtained here (Step E11).
[0101] The worker thread 181 reads the disk block obtained at Step E11, and in order to perform a DMA transfer to the transmission buffer 134 on the network card 130 passed from the interruption routine of the network card driver 170, it calls a disk driver 150 (Step E12).
[0102] A disk driver 150 tells the demand to a disk controller 140, and waits for completion (Step E13).
[0103] The disk demand processing means of a disk controller 140 once reads data from a disk 104, and stores the data in a disk cache 141. The cache data is transmitted to the transmission buffer 134 of the network card 130 to which it was directed at Step E12 (Step E14).
[0104] The disk demand processing means 142 of a disk controller 140 applies interruption to a processor 101 (Step E15).
[0105] The interruption routine of a disk driver 150 starts the worker thread 181 which is Step E13 and is waiting for the completion, and ends interruption processing (Step E16).

[0106] The worker thread 181 advances a data Request to Send to the network card 130 (Step E17).
[0107] This is because transmission could be directed on the network card 130 since the data of the remote file system demand (lead demand) demanded from the client computer 200 were ready on the network card 130.
[0108] The data included in the transmission buffer 134 are used for the remote file-processing means 136 of the network card 130, it creates the answer of a remote file system demand, and transmits it to the client computer 200 (Step E18).
[0109] Using the function of the local file system 160, the worker thread 181 issues read-out operation of a file, and waits for the completion (Step E19).
[0110] Originally there is no need of processing this file read-out demand. The lead demand demanded from the client computer 200 is because it has already processed. However, when the data read from the disk are stored in the buffer cache 121 of the server computer 100 and there is the next access, since the cache effect is expectable by enabling it to reuse, you may store data in the buffer cache 121.
[0111] Then, processing of the worker thread 181 is ended.
[0112] By lead demand, when there is nothing (No of Step E1), in a light demand, a light demand judges whether it is a write-through demand (Step E20).
[0113] In a write-through demand (Yes of Step E20) (i.e., the case of the demand which writes data in a disk immediately), the following processings are performed.
[0114] From the file of a file demand, offset, and a data length, the worker thread 181 calls the function of the local file system 160, and investigates whether the portion which should be carried out a light exists in the buffer cache 121 on a primary storage (Step E21).
[0115] Searching for the address of the buffer with which the local file system 160 corresponds when a buffer exists (Yes of Step E21), the worker thread 181 cancels the buffer using the function of the local file system 160 (Step E22). Since data are overwritten by the light demand which will process this from now on, the data on a primary storage 120 are because it is not necessary to return to a disk 104.
[0116] Using the function of the local file system 160, the worker thread 181 investigates a disk block and obtains the disk block which should carry out a light from the file of a file demand, offset, and a data length (Step E23).
[0117] The worker thread 181 advances a demand and waits for the completion so that the data on the receive buffer 135 of the network card 130 may be written in the disk block obtained at Step E23 using a disk driver 150 (Step E24).
[0118] The disk demand processing means 142 of a disk controller 140 applies interruption to a processor 101, after ending the writing of a disk 104 (Step E25).
[0119] The interrupt handler of a disk driver 150 starts the worker thread 181 which is waiting for completion at Step E24, and ends interruption processing (Step E26).
[0120] Since processing completed the worker thread 181, a demand is given for transmitting the answer to a remote file system demand to the client computer 200 to the network card 130 (Step E27).
[0121] The remote file-processing means 136 of the network card 130 transmits completion of a remote file system demand to the client computer 200 (Step E28).
[0122] The worker thread 181 inspects specification of light processing (Step E29).
[0123] Processing will be ended if it is the mode in which light processing does not use the buffer cache 121 (No of Step E29).
[0124] In order to put data into the buffer cache 121 in the case of the mode in which light processing uses a buffer (Yes of Step E29), the function of the local file system 160 is used for the worker thread 181, it processes a lead demand, and waits for the completion (Step E30).
[0125] Originally it is not necessary to also perform this lead demand, when processing a remote file system demand, the buffer cache 121 is used -- bending -- it is because it is usually that which is meaningful in the client computer 200
[0126] Therefore, there may not be Step E30.
[0127] Then, processing of the worker thread 181 is ended.

[0128] The following processings are performed when a light demand is not a write-through (No of Step E20).
[0129] The worker thread 181 judges whether the portion which should be carried out a light exists in the buffer cache 121 on a primary storage from the file of a file demand, offset, and a data length using the function of the local file system 160 (Step E31).
[0130] When a buffer exists (Yes of Step E31), the address of the corresponding buffer can be acquired. The following processings are performed when a buffer exists.
[0131] The worker thread 181 performs processing which locks the buffer obtained at Step E31 using the function of the local file system 160 (Step E32).
[0132] The worker thread 181 gives a demand to the remote file-processing means 136 of the network card 130, and waits for the completion so that the address of the data in a receive buffer 135 and the address on the buffer cache 121 may be set to the transfer-request register 131 and the DMA transfer of the data in the receive buffer 135 on the network card 130 may be carried out based on this address to the address on the buffer cache 121 obtained at Step E31 (Step E33).
[0133] By this transfer, the data on the buffer cache 121 will be transposed to the data of a remote file demand (light demand).
[0134] If a DMA transfer is completed, the remote file-processing means 136 of the network card 130 will set a status register to 3, and will apply interruption to a processor 101 (Step E34).
[0135] The interruption routine of the network card driver 170 starts the worker thread 181 for which it waits at Step E33, and completes interruption (Step E35).
[0136] A worker thread cancels the lock of the buffer on 181 and the locked buffer cache 121 (Step E36).
[0137] Then, processing of the worker thread 181 is ended.
[0138] The following processings are performed when there is no buffer (No of Step E31).
[0139] Using the function of the local file system 160, the worker thread 181 secures a buffer on the buffer cache 121 (Step E37), and locks the buffer (Step E32).
[0140] After Step E32, the same processing as the case where there is a buffer is continued.
[0141] As mentioned above, conventionally, the data transfer between the network card 130 and a disk once had to accumulate data to the primary storage 120, and had to perform them to it. However, according to this invention, immediate data can be exchanged between the network card 130 and a disk controller 140 because the network card 130, the network card driver 170, a disk driver 150, and a file system process a remote file system demand in cooperation. Moreover, since the exchange of the data is performed maintaining consistency with the buffer of the file system on a primary storage 120, the function in which the local file system 160 on the server computer 100 operates the data on a disk 104 is maintained.
[0142]
[Effect of the Invention] Since according to this invention it is in a network card and a disk controller and remote file manipulation is processed as a full account was given above, performing protocol processing, file processing, etc. for processing remote file manipulation of the processor of a server computer is lost, and it can assign resources and time to the other processing.
[0143] for example, although the same data flowed twice on the system bus with the conventional technology in order in light processing to transmit data to a primary storage from a network card and to transmit data to a disk from a primary storage further, since data are transmitted to a disk only using an I/O bus from a network card, a transfer of the data using a system bus is unnecessary according to this invention

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[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block diagram showing the network file server structure of a system concerning the gestalt of 1 operation of this invention.
[Drawing 2] Drawing showing the data composition of the file demand buffer concerning the gestalt of this operation.
[Drawing 3] The flow chart which shows processing operation in the case of reception of the network card of the gestalt of this operation.
[Drawing 4] The flow chart which shows processing operation in the case of the DMA transfer of the network card concerning the gestalt of this operation.
[Drawing 5] The flow chart which shows processing operation in the case of transmission of a network card with respect to the gestalt of this operation.
[Drawing 6] The flow chart which shows processing operation of the interrupt handler of a network card driver with respect to the gestalt of this operation.
[Drawing 7] The flow chart which shows processing operation of a worker thread with respect to the gestalt of this operation.
[Drawing 8] Drawing showing the conventional network file server structure of a system.
[Description of Notations]
10 -- Server computer
11 -- Processor
12 -- System bus
13 -- PCI bus
14 -- Primary storage
15 -- Buffer cache
16 -- Disk controller
17 -- Disk
18 -- Network card
19 -- Receive buffer
20 -- Network driver
21 -- Protocol stack
22 -- Remote file system
23 -- Local file system
24 -- Network
25 -- Client computer
100 -- Server computer
101 -- Processor
102 -- System bus
103 -- I/O bus
104 -- Disk
120 -- Primary storage
121 -- Buffer KYASHU
122 -- Transmission buffer

123 -- Receive buffer
130 -- Network card
131 -- Transfer-request register
132 -- Status register
133 -- File demand buffer
1330 -- Remote file demand
1331 -- File name
1332 -- Offset
1333 -- Data length
1334 -- Data address
134 -- Transmission buffer
135 -- Receive buffer
136 -- Remote file-processing means
1360 -- Packet analysis section
140 -- Disk controller
141 -- Disk KYASHU
142 -- Disk demand processing means
150 -- Disk driver
160 -- Local file system
161 -- Lock function
162 -- Unlocking function
170 -- Network card driver
180 -- Remote file system
181 -- Worker thread
200 -- Client computer
300 -- Network
1330 -- Remote file demand

[Translation done.]